

A DEVICE FOR REARING ANIMALS REQUIRING A FLOWING WATER ENVIRONMENT

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The usual method of rearing animals that live in flowing water is to place them in screened cages either partially or completely submerged in a stream. This method has several drawbacks: cages are subjected to destruction by floods and inquisitive humans, no provisions can be made for temperature and food controls, and more specifically, the screen reduces the velocity of water inside the cage. In order to simulate stream conditions as much as possible without the difficulties mentioned, a "stream-tank" has been devised.

With this equipment, a free flowing current of water is provided in which objects may float continuously. It provides methods for controlling the velocity of the water and the height of the water level, and it is a self-contained unit which facilitates the feeding of specimens contained therein. This equipment was designed specifically to study the effects of flowing water on mosquito larvae, but with a few modifications, it might be used in work with other species of animals living in flowing water.

In this stream-tank, water is drawn from a reservoir and pumped, through two distributing arms which terminate in special nozzles, into the main channel of the tank to produce the water flow. The rate of introduction of water into the main channel, which is regulated by a valve, regulates the rate of flow of the water in the tank. Velocities up to four feet per second may be obtained in the stream-tank. As the water is pumped into the channel, drainage takes place underneath a separating wall between the main channel and a narrower secondary channel, and from this secondary channel the water drains by gravity through drain gates back into the reservoir, from which it is recirculated. The drain gates are adjusted to provide an *exact balance* between the rate of drainage and the rate of pumping into the tank; thus a continuous flow of water is produced and a constant water level is maintained.

DETAILS OF CONSTRUCTION

The stream-tank was constructed from the writer's original drawing by a furnace repairing establishment and the materials used were 24 gauge galvanized iron, copper screening, solder, and rivets.

The main channel is 8 inches wide and has a center circumference of 14 feet. The outer side wall is $10\frac{1}{2}$ inches high and will permit water depths up to 9 inches. A flat plastic ruler may be attached to the wall of the main channel to enable reading water levels at a glance. In order to retain mosquito larvae in the channel and to avoid a congregation of the larvae at any central drainage point, a secondary channel of 4 inches was added. The galvanized iron separating wall between the two channels was placed $\frac{1}{8}$ inch off the floor of the tank, being retained in position by L-shaped metal brackets on the bottom. Several separator strips (10)², 4 and 8 inches long were placed over the tops of the channels to retain the regular oval shape of the tank (fig. 1). The 4 inch strips were permanently fastened,

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²The numbers in parentheses refer to details illustrated usually in both figures 1 and 2.

while the 8 inch strips are removable to permit rapid cleaning of the tank. Ten evenly spaced ports were cut in the bottom of the separating wall to provide additional drainage. A port consisted of two 1 inch cuts about 3 inches apart with this 3 inch flap bent toward the main channel. Gravel (8), approximately

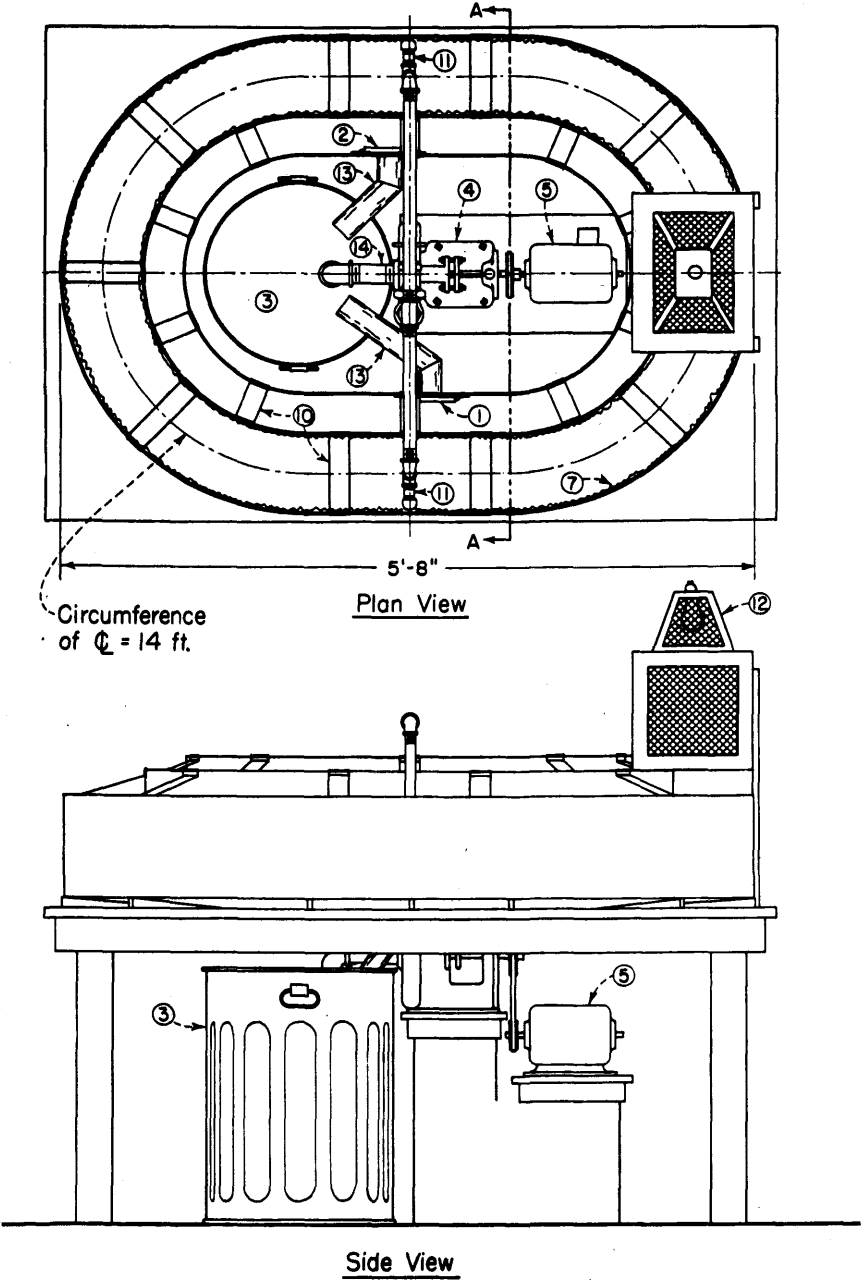


FIGURE 1. The stream-tank. (Drawn by Clyde Kearns.)

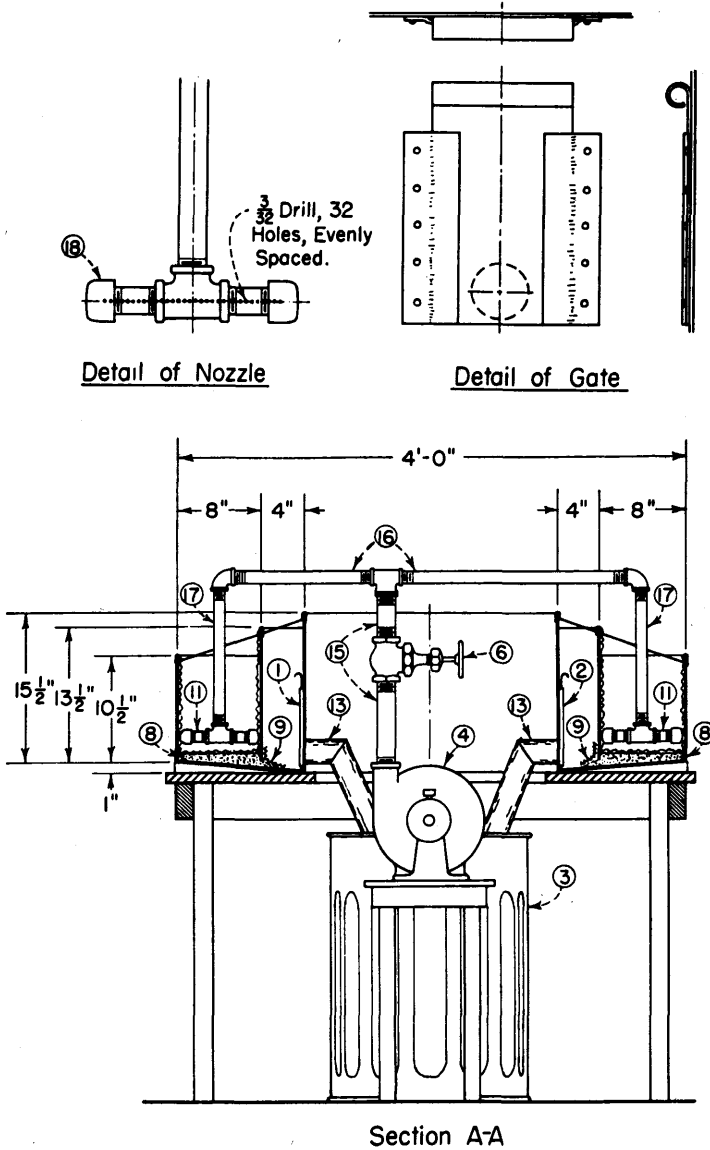


FIGURE 2. The stream-tank. (Drawn by Clyde Kearns.)

KEY TO NUMBERS SHOWN IN THE PLATES

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|---------------------------|--------------------------------|
| 1, 2. Drain gates. | 11. Nozzles. |
| 3. Reservoir. | 12. Mosquito cage. |
| 4. Pump. | 13. Drain pipes. |
| 5. Motor. | 14. Suction pipe. |
| 6. Globe valve. | 15. Discharge pipe. |
| 7. Organdy cloth. | 16. Distributor pipe, 1". |
| 8. Gravel. | 17. Distributor pipe, 3/4". |
| 9. Copper screening. | 18. 3/4" Galvanized iron caps. |
| 10. 4" and 8" Separators. | |

$\frac{1}{4}$ inch in diameter, was put in the main channel to a depth of 1 inch to diffuse drainage. To retain the gravel in the main channel, 16-mesh copper screening (9) was soldered to the bottom of the tank and the bottom of the separating wall on the secondary channel side.

The addition of organdy fabric (7) to the sides and bottom of the main channel was required because the larvae would disappear amidst the gravel. The organdy was cut to pattern, sewed together into a U-shaped shell, and held in position by strips of metal 1 inch x 20 inch, bent U-shaped and inverted in the main channel.

The drain pipes (13) were attached directly on the bottom of the wall toward the center of the equipment, and carried the water to the reservoir (3), which had a 32 gallon capacity. To assist in the drainage, the entire tank was mounted on metal bases that forced a 1 inch downward slope of the bottom toward the reservoir which is in the center of the equipment. This arrangement (fig. 2) permitted a continuous flow of water of constant depth to circulate in the main channel and a sufficient drain-off of water without causing a congregation of larvae at any single point or points.

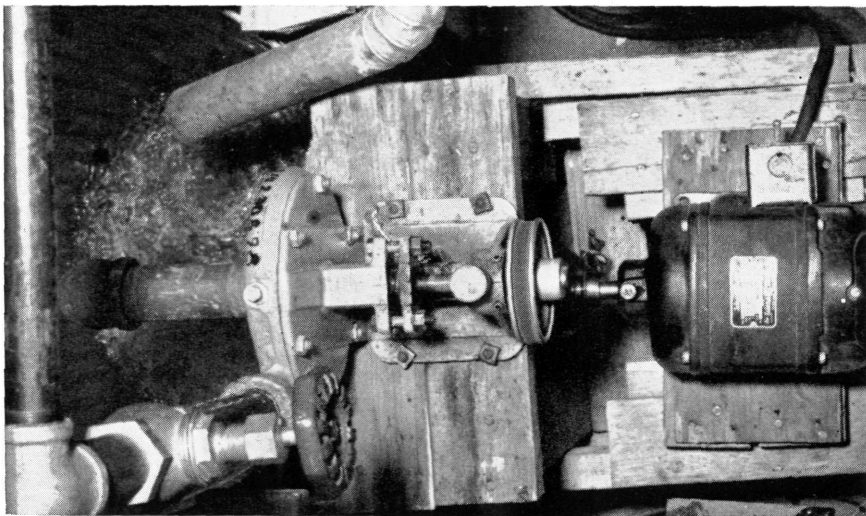


FIGURE 3. Detail of stream-tank. This view shows the motor, pump, valve and drain pipe as seen from above.

The centrifugal pump (4) used has a rated capacity of 67 g.p.m. at 1725 r.p.m. This type of pump was chosen because of the uniform flow it produces. The electric motor (5) used to drive the pump is rated at 1 hp. and 3450 r.p.m., and to obtain the proper speed for the pump, a 2 inch pulley was placed on the motor and a 4 inch pulley on the pump (fig. 3). The pulleys were of the Vee-type, and a 32 inch belt was employed to connect the two pulleys. The stream-tank, the pump, and the motor were all mounted on substantial wooden tables made of 2 inch x 4 inch lumber with the top of the table supporting the tank made of $\frac{3}{4}$ inch material. The supports for the pump and motor were nailed together as one piece and it was made completely free of the table for the tank in order to eliminate excessive vibration of the tank by the pump and motor.

The galvanized pipe required to carry the proper volume of water to the pump was $1\frac{1}{2}$ inches in diameter (14). A 32 inch length of this pipe was used to draw the water from the reservoir; it was connected to the pump by a 4 inch section and

an elbow. On the discharge side of the pump, an 8 inch section of $1\frac{1}{4}$ inch pipe was used (15). Connected directly to this section was the $1\frac{1}{4}$ inch globe valve (6). Another 4 inch section of $1\frac{1}{4}$ inch piping was employed coming out of the valve. A 1 inch x 1 inch x $1\frac{1}{4}$ inch reduction tee was placed on the last section of $1\frac{1}{4}$ inch pipe to reduce the piping to 1 inch. At the discharge end of each 1 inch distributing pipe (16), a 1 inch to $\frac{3}{4}$ inch reduction elbow was fitted. Each downward distributing arm from these elbows was $\frac{3}{4}$ inch pipe (17). The nozzles (11) were formed by joining two nipples to a $\frac{3}{4}$ inch tee and placing caps (18) at each end. Thirty-two evenly spaced holes were drilled across the entire face of the nozzles, including the tee and both caps (fig. 2). The bore of the holes was $\frac{3}{32}$ inch, and the length of the nozzles when assembled was $7\frac{1}{2}$ inches.

In order to retain any emerging adults in the stream-tank, marquisette netting was taped to the separating wall and pulled over the main channel, where it was fastened with clothes pins (fig. 4). To facilitate observations on the water level and the specimens in the stream-tank, several sections of celluloid were taped over cut-out portions of the netting. In conjunction with this netting, a regular

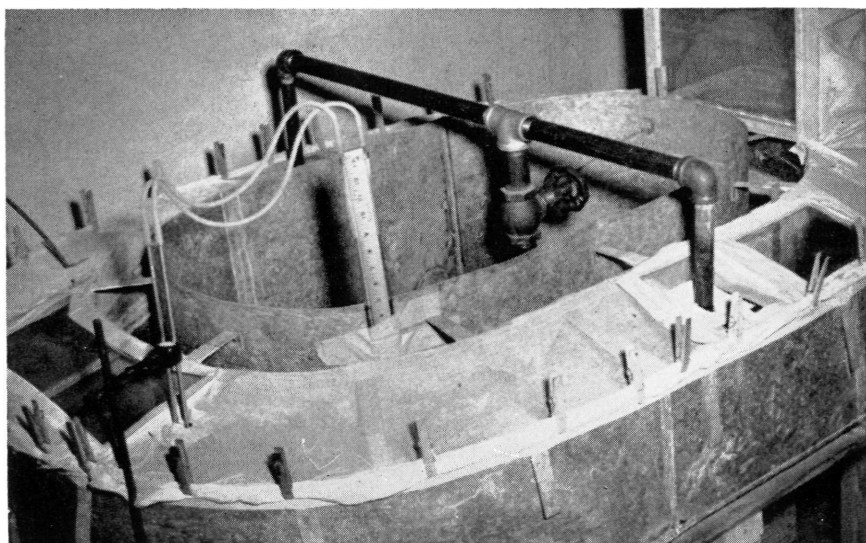


FIGURE 4. The stream-tank. This view gives the over-all plan of the stream-tank. The flow of water was clockwise.

mosquito cage 12 inches x 16 inches x 11 inches (12) was placed over one end of the tank with the bottom cut out to fit the curve of the main channel. More marquisette was taped around the free spaces between the tank and the cage. In order to attract the adults, a 60-watt bulb was placed over the cage. When the room was dark, the bulb was turned on. However, when all the lights were on during the day, the cage was darkened to attract the adults. The adults were removed from the cage by inserting a masonite bottom, then suctioning them out of the sleeve side of the cage.

OPERATION OF THE STREAM-TANK

To place the stream-tank in operation, drain gates (1, 2) were closed and the reservoir one-half filled with water by means of a garden hose. As soon as this was completed, the hose was quickly transferred to the secondary channel, filling the main channel indirectly to avoid disturbing the bed of gravel. When the

desired water level was reached in the main channel, the hose was removed. The entire system contains 65 gallons of water when the tank level is 5 inches and the reservoir half full.

The pump was primed and the motor started. Drain gate (2) was opened slightly and the globe valve (6) opened enough to cause the desired velocity in the main channel. The velocity was measured by using a Pitot tube or by measuring the speed of a floating object in the main channel. After the desired velocity was reached, drain gate (1) was raised or lowered until the desired water level was obtained. The ruler guide was watched for a period of time to be sure that the water level was maintained.

When cool tap water was introduced into the system, the equipment was allowed to run for several hours until the water temperature was stabilized. If the air temperature was constant, the water temperature would remain constant, but it would remain several degrees higher than the air temperature.

DISCUSSION

The stream-tank has been operated for a period of six months and has worked satisfactorily, but several details remain to be smoothed out. Better control of drainage could probably be obtained by replacing the gate type valve with a globe type valve. The organdy fabric deteriorates after six weeks of constant usage. A search is being conducted for a more resistant fabric. Nylon fabric is currently being tested and shows some promise.

In some respects the stream-tank does not exactly simulate stream conditions. The cross section of the main channel is rectangular, while a stream cross section is somewhat curved; the stream-tank channel may be altered by placing the gravel in the bottom of the tank and arranging it to obtain the desired curvature. The water velocity in an actual stream varies from zero at the point of contact with the stream bank to a maximum several inches below the surface at midstream; the velocity of water in the stream-tank is always greatest at midstream and greater at the outer periphery than at the inner periphery.
